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Publication date:
2014

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Harms, I. M., & Brookhuis, K. A. (2014). *Traffic managed? Why not all drivers can adhere to changes in speed limit signals over the road*. Paper presented at 28th International Conference of Applied Psychology, Paris, France.

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Traffic managed? Why not all drivers can adhere to changes in speed limit signals over the road

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Mini paper: abstract submission number ICAP14-ABS4322

Abstract

Perceiving changes in variable speed limits is a prerequisite for speed limit compliance. However, under certain circumstances our ability as drivers to detect such changes around us is restrained. Variable speed limits embody traffic management information which drivers regard as very important and they will therefore be perceived more often. The present study focussed on the detectability of an expected change on a familiar route and compared two traffic management approaches – only display information when necessary versus display information continually – in terms of the ease with which drivers perceive changes in this type of traffic management information. In a 2x3 design, change detection for variable speed limits was measured for information addition and information change under three conditions of information discriminability. Participants were repeatedly shown videos of a single motorway to familiarise them with the route. Although all drivers were aware of an imminent change and (almost) all expected the variable speed limits to change, 5.2% still failed to detect when the speed limits had actually changed. Though this number seems small, the absolute number of cars on motorways missing the change is unacceptable. The results are discussed in relation to detectability of, recollection of, and expectations about the new speed limit. This study provides insight into change detection failure for dynamic traffic management information and possible countermeasures.

Keywords: change blindness, perception, variable speed limits, dynamic traffic management

Introduction

Speed limits are considered one of the most meaningful, best perceived and best recollected road signals (Hoogendoorn et al., 2012). As part of dynamic traffic management (DTM) variable speed limits (VSLs) have been introduced to influence real-time driver behaviour, by just changing the VSLs to fit the present situation on the road and/or the road network. This way road authorities can improve both traffic safety as well as traffic circulation. Thus far, research on compliance with speed limits has mainly been focussed on topics such as credibility. However, with the introduction of VSLs the question rises whether drivers will actually be able to perceive the *changes* in VSLs, a prerequisite for speed limit compliance. Studies have shown that our ability to detect changes around us is limited (for a review see Simons & Levin, 1997). This limitation in detecting changes which are in fact clearly visible is called change blindness.

Method

Experimental design

Using an intentional approach, in which the observer is instructed to fully expect a change (cf. Simons & Mitroff, 2001), participants were shown fifteen short videos and one practice video. All videos represented a motorway equipped with three gantries displaying VSLs. The first video was displayed unchanged and viewed thirteen times to familiarise participants with the route. The change was introduced in the 14th video and involved changing the VSLs from 100 km/h to 80 km/h on the second and the third gantries. Video 15 consisted of a recollection test.

In a 2x3 design, change detection was measured for information addition (IA) and information change (IC), under three conditions of information discriminability (Basic, Flash and Wave). In the IA condition, the VSL signs were always turned off, unless the speed limit changed; in the IC condition, the VSL signs were always turned on, hence depicting a speed limit on every VSL sign (see Figure 1). The three conditions of information discriminability varied in how the first, changed speed limit was displayed (see Figure 2). In the Flash condition, it was shown with alternating orange flashers; in the Wave condition, it appeared as if the speed limit was moving in a wave-like manner.

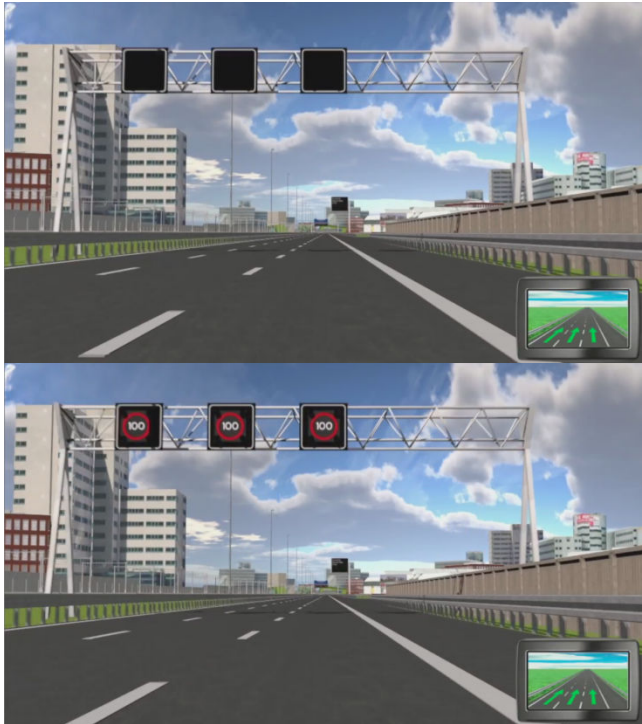


Figure 1. Screen shot of the second gantry in the IA condition (top) and in the IC condition (bottom) in video 1 to 13.

Participants

Participants accessed the experiment on their own computer. 255 Participants completed the experiment successfully. The groups of participants did not differ significantly for background variables such as age, gender and amount of kilometres driven in the past twelve months.

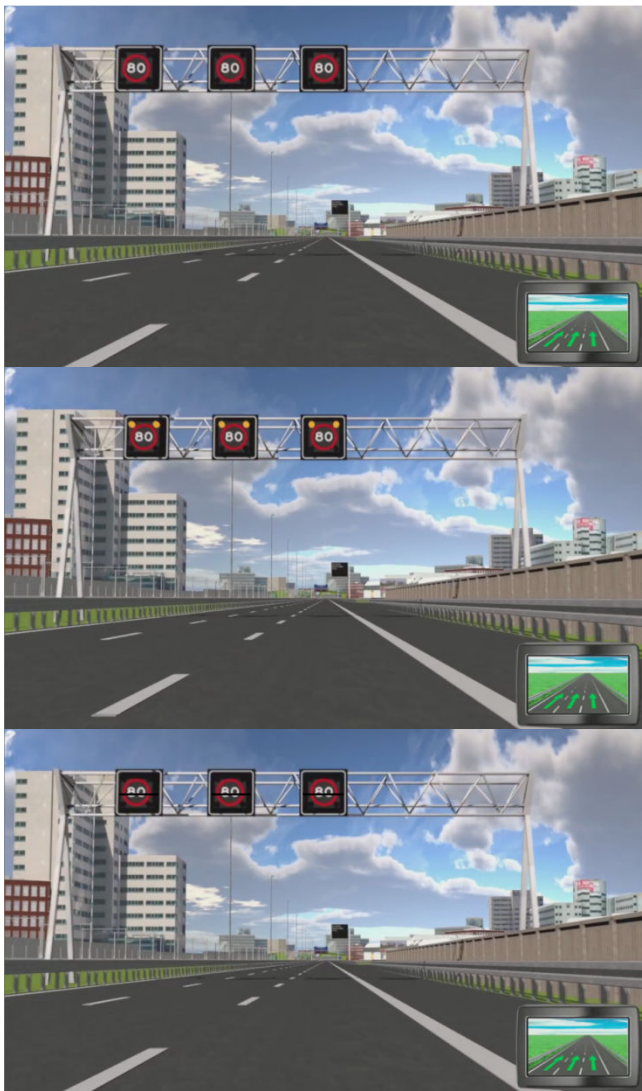


Figure 2. Screen shot of the second gantry under three conditions of information discriminability in video 14. From top to bottom: Basic, Flash, and Wave.

Results

Expectancy and detection accuracy

In video 14, 76.2% of the participants accurately responded to both speed limit changes. Other participants only responded to the second change (3.2%), or did not respond to the changes at all (2.0%). Due to a technical error three participants were unable to stop video 14, hence $n=252$ for video 14. Almost all participants (94.5%) had expected that the VSLs would change, including all participants who failed to respond to the changes at all.

Detection accuracy differed slightly for IA (4.6% not detected) versus IC (5.8% not detected). Adding motion to the first changing speed limit decreased detection accuracy (see Figure 3).

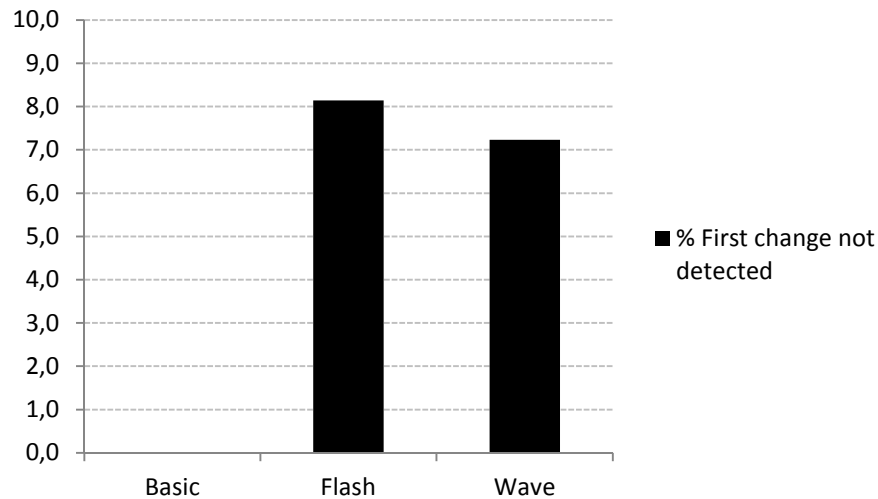


Figure 3. Detection accuracy for the first speed limit change under three conditions of information discriminability.

Speed limit recollection

While viewing video 15, 34.9% of the participants accurately recollected the speed limits shown in video 14. Most participants (47.5%) falsely recollected all VSLs to have changed to 80 km/h (see Figure 4).

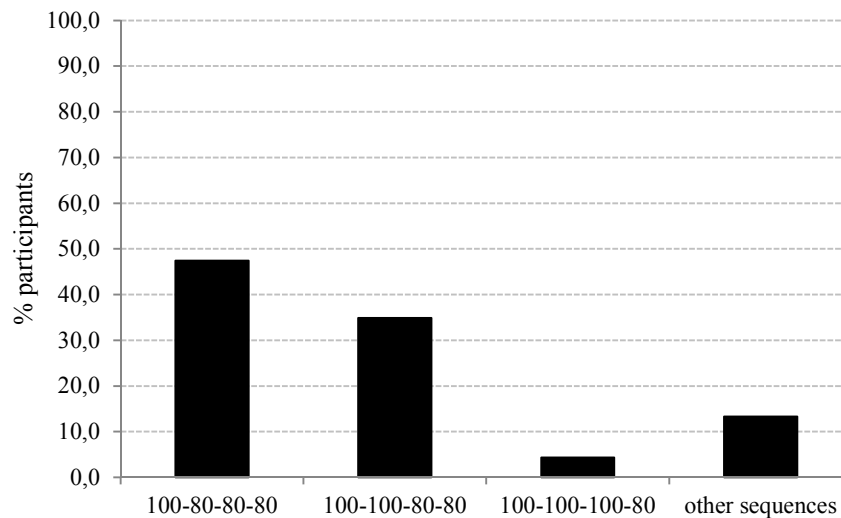


Figure 4. Recollected speed limit sequences in video 15. The correct sequence is 100 km/h, 100 km/h, 80 km/h, and 80 km/h.

Reaction time

The mean reaction time for the first change in video 14 is significantly lower for IA than for IC [$t(237) = -2.81, p < 0.01$]. For the second change the effect remains, though it is less strong [$t(198) = -1.66, p < 0.10$]. Compared to Basic and Wave, Flash yields the highest reaction time [$F(2,236) = 6.12, p < 0.00$]. However, the variance in reaction times is much smaller for Flash [Levene Statistic (2,236) = 8.31, $p < 0.00$] (see Figure 5).

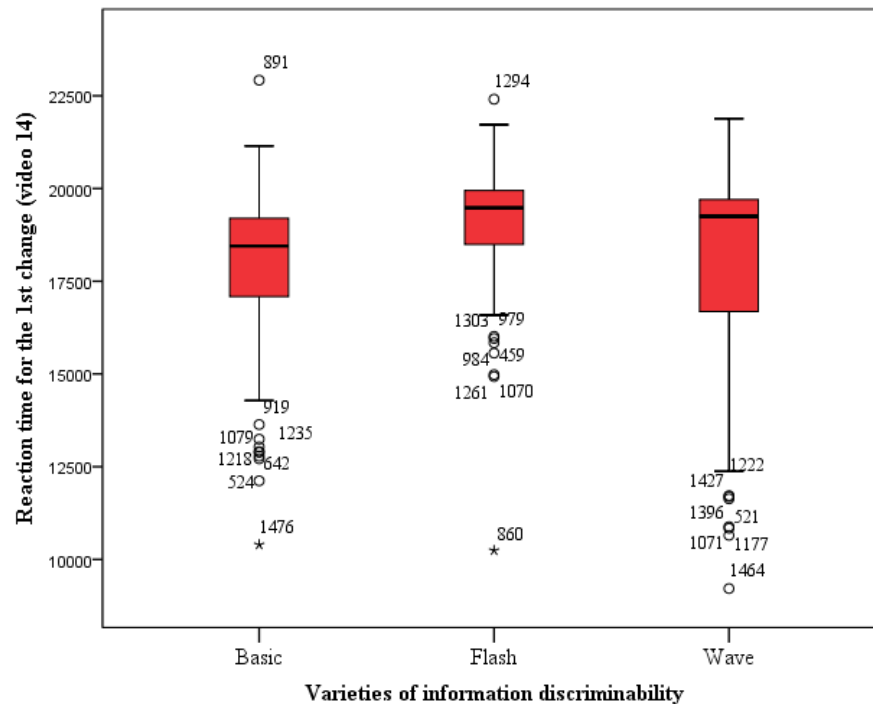


Figure 5. Boxplots of reaction times for the first change in video 14 for the three types of information discriminability. Reaction times are measured from the start of the video.

Discussion

Previously, Harms (2012) showed that 37.5% of the drivers in a simulator study failed to notice changes in VSLs on a familiar route. This time, the study was designed to “force” participants to see the decreased speed limit, yet still 5.2% did not (timely) detect it. The conclusion must be that expecting a change does not necessarily result in change detection. Detecting changes in VSLs is specifically important for maintaining the correct speed on motorways as perceiving the relevant information is one of the necessary steps to be able to comply with speed limits in the first place.

Though the number of change detection failures seems small, the absolute number of cars on motorways missing the change is unacceptable. Only displaying VSLs when speed limits change may provide a possible countermeasure which road authorities could use to improve VSL compliance. This is in line with previous change detection studies. Contrary to these earlier findings, adding motion to a changing speed limit did not result in the desired improvements (for a review see Rensink, 2002).

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